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Efficient Control and Automation: Exploring Siemens LOGO PLC and PLC-Based Industrial Timer Controllers

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ABSTRACT

Siemens LOGO PLC is a compact system for small automation projects, programmed via LOGO Soft Comfort. Its graphical interface enables easy circuit program creation, facilitating customized control systems swiftly. LOGO Soft Comfort allows offline and online testing, simulation, and program archiving. PLC timers, integral to the system, regulate input and output signals, functioning like relay timers without physical presence or wiring. This paper delves into PLC-based industrial timer controllers, designed to supersede traditional hard-wired relay and timer logic systems. Common PLC timers include Pulse, On-delay, Retentive On-delay, and Off-delay timers, pivotal for time delays and production monitoring in industries. They facilitate actions like turning machines off after set periods or initiating them after specific delays upon sensor activation or button press.

Keywords: Siemens LOGO PLC; PLC timers; LOGO Soft Comfort; Industrial automation; Circuit programming; Programmable logic controllers; Time-based control; Process automation; Control systems; Relay logic.

1. Introduction

In the world of industrial automation, the drive for efficiency and precision remains paramount. Siemens LOGO PLC is a beacon of innovation, providing a tiny yet powerful control system designed for small-scale automation projects [1]. With its user-friendly interface and seamless interaction with LOGO Soft Comfort software, program creation and editing becomes not only manageable, but also intuitive [2]. The role of timers in industrial automation cannot be emphasized. Timers, which act as virtual clocks in PLC programming, play an important role in orchestrating sequences of events at precise time intervals [3]. Timers are essential instruments in a wide range of industrial applications, from generating time delays to triggering operations at predetermined intervals. A number of studies have looked into the design and building of PLC-based industrial timer control systems [4]. Kejian et al. (2010) and Patel et al. (2020) both focus on the use of FPGA platforms, with Kejian et al. presenting a method for designing a small PLC timer system and Patel proposing a module for delay timers [5-6]. Zhao and Liu (2011) presents four kinds of time-delay contacts using PLC timer for different applications and validates the ladder diagrams and waveforms in a specific PLC control unit for direct use [7]. Alia et al. (2011) extends the discussion by developing virtual instruments for PLC functions, including various timing Vis [8]. These studies collectively contribute to the advancement of PLC-based timer control systems, with a particular emphasis on FPGA platforms and practical applications.

The use of PLC-based systems, particularly the Siemens LOGO PLC, has been explored in various industrial automation applications. He and Chen (2021) demonstrated the use of a Siemens S7-200 PLC for closed-loop positioning control in a plastic steel profile sawing center, improving accuracy and reducing costs [9]. Singh (2019) highlighted the benefits of automation in cutting costs and improving performance, with a focus on data acquisition and control using SCADA software and PLC [10]. Chattal et al. (2019) further emphasized the role of PLC, along

with LabVIEW and internet interface, in automating an industrial system for mixing limestone powder and hot water [11]. Kuo et al. (2016) proposed the use of Precision Timed Industrial Automation (PTIA) Systems for safety-critical applications, addressing the timing correctness of PLCs [12]. These studies collectively underscore the efficiency and versatility of PLC-based control and automation, particularly in the context of Siemens LOGO PLC. This paper delves into the intricate realm of PLC-based timer controllers, with a specific focus on Siemens LOGO PLC. By exploring the functionalities and capabilities of PLC timers, we aim to shed light on their role in enhancing efficiency and productivity within industrial settings. Moreover, we delve into the practical applications of PLC timers, demonstrating their utility in scenarios ranging from production monitoring to machine control. Through this exploration, we endeavor to provide insights that not only deepen understanding but also inspire further innovations in the field of industrial automation. The novelty of this work lies in its focus on developing a PLC-based industrial timer control system tailored to address the specific needs and challenges of modern manufacturing processes. While PLC technology and timer functionalities are well-established in industrial automation, this research endeavors to innovate by designing a control system that not only harnesses the capabilities of PLCs but also optimizes them for enhanced efficiency, reliability, and adaptability in diverse industrial settings. Furthermore, this work seeks to explore novel applications and functionalities of PLC timers beyond conventional uses, potentially unlocking new avenues for process optimization and automation. By pushing the boundaries of traditional PLC-based control systems, this research aims to contribute to the advancement of industrial automation technology and empower manufacturers to stay competitive in an ever-evolving market landscape.

1.1. Study Objectives

In this subsection, we delineate the specific aims driving our examination of Siemens LOGO PLC and PLC-based industrial timer controllers: (i) To comprehensively understand the compact system of Siemens LOGO PLC and its applicability in small-scale automation projects. (ii) To delve into the programming interface provided by LOGO Soft Comfort, facilitating efficient circuit program creation for tailored control systems. (iii) To assess the functionality and utility of PLC timers integrated into Siemens LOGO PLC, comparing them with traditional hard-wired relay and timer logic systems. (iv) To investigate the practical implications of PLC-based timer controllers in industrial automation processes, focusing on time delays and production monitoring. (v) To analyze the diverse applications and advantages offered by different types of PLC timers, including Pulse, On-delay, Retentive On-delay, and Off-delay timers, across various industrial contexts.

1.2. Motivation

The motivation for this research stems from the critical role of automation and control systems in modern industrial settings. Siemens LOGO PLC, coupled with LOGO Soft Comfort software, offers a compact and versatile solution for small automation projects. However, despite its widespread use, there is a need for a deeper understanding of its capabilities, particularly in the context of timer control applications. By exploring the functionality and performance of PLC-based timer controllers, this research aims to address this gap and contribute to the optimization of industrial processes. Additionally, with the increasing demand for efficiency and precision in manufacturing, there

is a growing reliance on timer control systems to manage time delays and production sequences effectively. Understanding the practical implementation and performance of PLC-based timer controllers is thus essential for enhancing operational efficiency and meeting industry demands. Ultimately, this research endeavors to provide valuable insights that can inform the design and deployment of efficient control systems in industrial settings, thereby driving improvements in productivity and performance.

2. Methodology

The methodology involves conducting a literature review to gather information on Siemens LOGO PLC, LOGO Soft Comfort software, and PLC-based timer controllers. Subsequently, proficiency in using LOGO Soft Comfort is attained through hands-on training. Common industrial applications utilizing PLC timers are identified, followed by the setup of a PLC-based industrial timer controller using Siemens LOGO PLC hardware and LOGO Soft Comfort software. PLC programs are then developed for various timer applications using the software's programming capabilities. Offline and online testing are conducted to ensure functionality and accuracy, with subsequent evaluation of the PLC-based timer controller's reliability, accuracy, and efficiency. Its robust design enables seamless integration into industrial environments, facilitating the automation of various manufacturing processes. Central to PLC functionality is the timer module, comprising an internal clock, a count value register, and an accumulator, primarily employed for timing operations. In numerous control tasks, temporal programming is indispensable, making timer instructions a fundamental component of PLC programming for creating precise time delays within programs.

3. Sequence of Operations in a PLC Simulation Program

In this section the sequence of operations and view of the simulation program is analyzed. The simulation program describes the sequence of steps involved in operating a PLC (Programmable Logic Controller) system using a LOGO PLC OBA6 model. The following steps of operation are given below:

a. Switch on the Power Supply

- The first step involves turning on the power supply to the PLC system, ensuring that it is ready for operation.

b. Select the PLC Digital Input Signal

- Using a selector switch, choose the appropriate digital input signal for the desired timer mode. The LOGO! PLC OBA6 has a total of 8 input signal ports: I_1, I_2, I_3, I_4, I_5, I_6, I_7, and I_8.

- I_1: On Delay Timer Digital Input Signal

- I_2: Off Delay Timer Digital Input Signal

- I_3: Pulse Timer Digital Input Signal

- I_4: Retentive On Delay Timer Digital Input Signal

- I_5: On Push Digital Input Signal

- I_6: Off Push Digital Input Signal

- I_7: Spare

- I_8: Spare

c. Press the On Push Button for System Run

- Activate the system by pressing the "On Push" button, initiating the operation of the PLC system.

d. PLC Ladder Logic Internal Operation

- Once the "On Push" button is pressed, the PLC ladder logic internally executes, entering a selection mode where it processes the input signals based on the chosen timer mode.

e. Output Signal Generation

- Upon completion of the ladder logic processing, the PLC generates output signals based on the programmed logic. The LOGO! PLC OBA6 has a total of 4 output signal ports: Q_1, Q_2, Q_3, and Q_4.

- Q_1: Motor Run Signal

- Q_2: Valve Run Signal

- Q_3: Spare

- Q_4: Spare

f. Press the Off Push Button for System Shutdown

- To shut down the system, press the "Off Push" button, causing the PLC to deactivate and halt its operations.

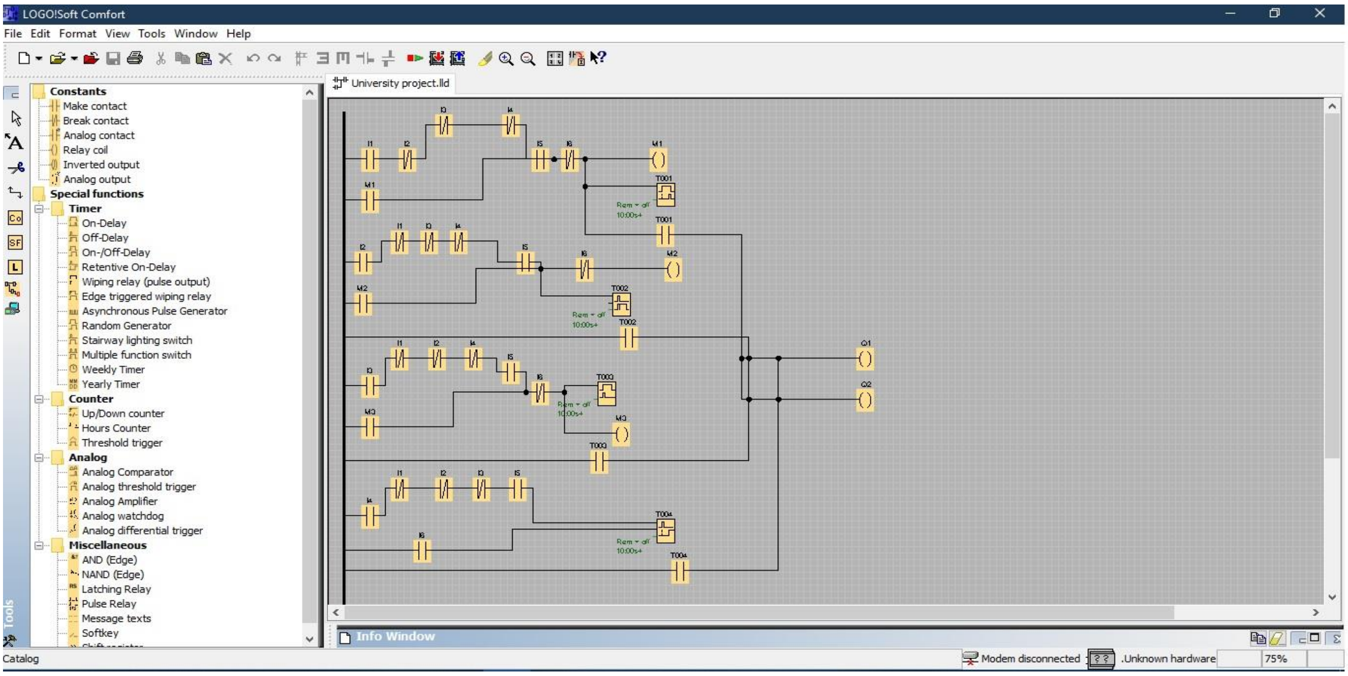

Figure 1. Edit mode of the PLC program full screen view by LOGO Soft Comfort

Figure 1 shows the preliminary setup of the edit mode of the PLC simulation view of LOGO soft comfort. By changing the command of the code we get different operations and modes of this arrangement.

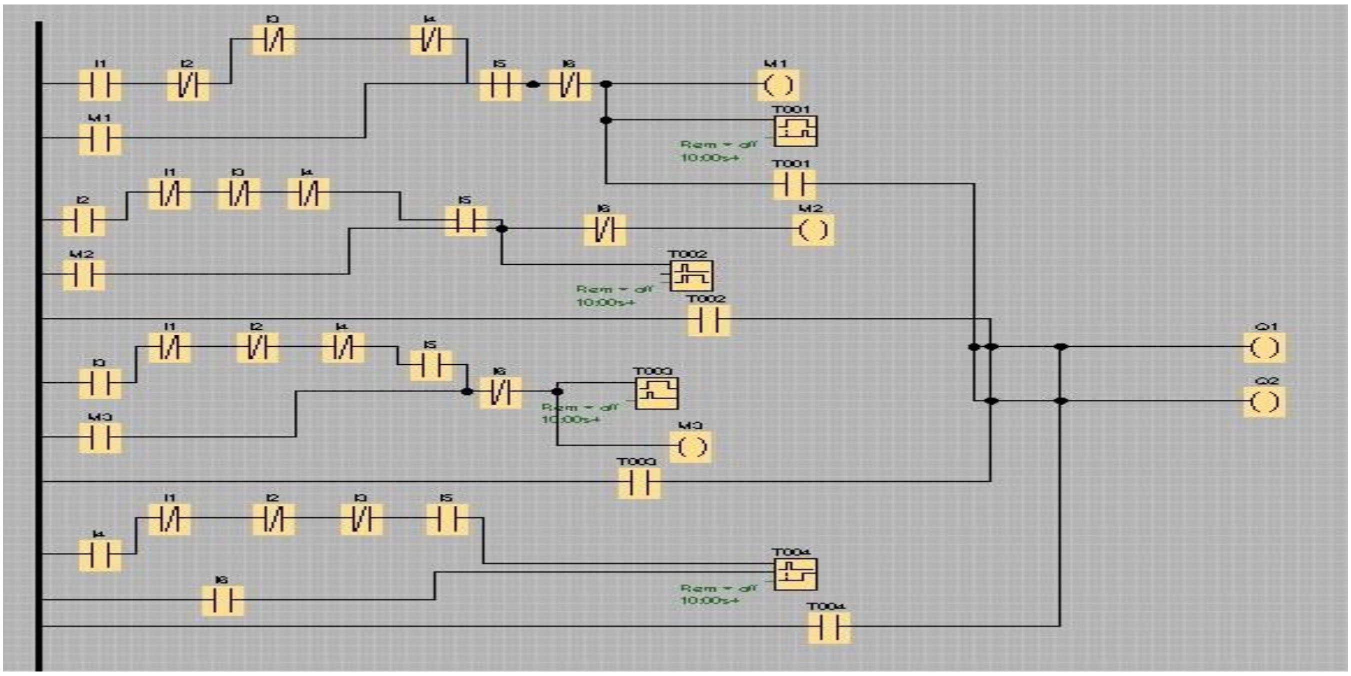

Figure 2. PLC program normal view by LOGO Soft Comfort

Figure 2 illustrates the normal view of LOGO soft comfort. In this arrangement no commands are given from the code.

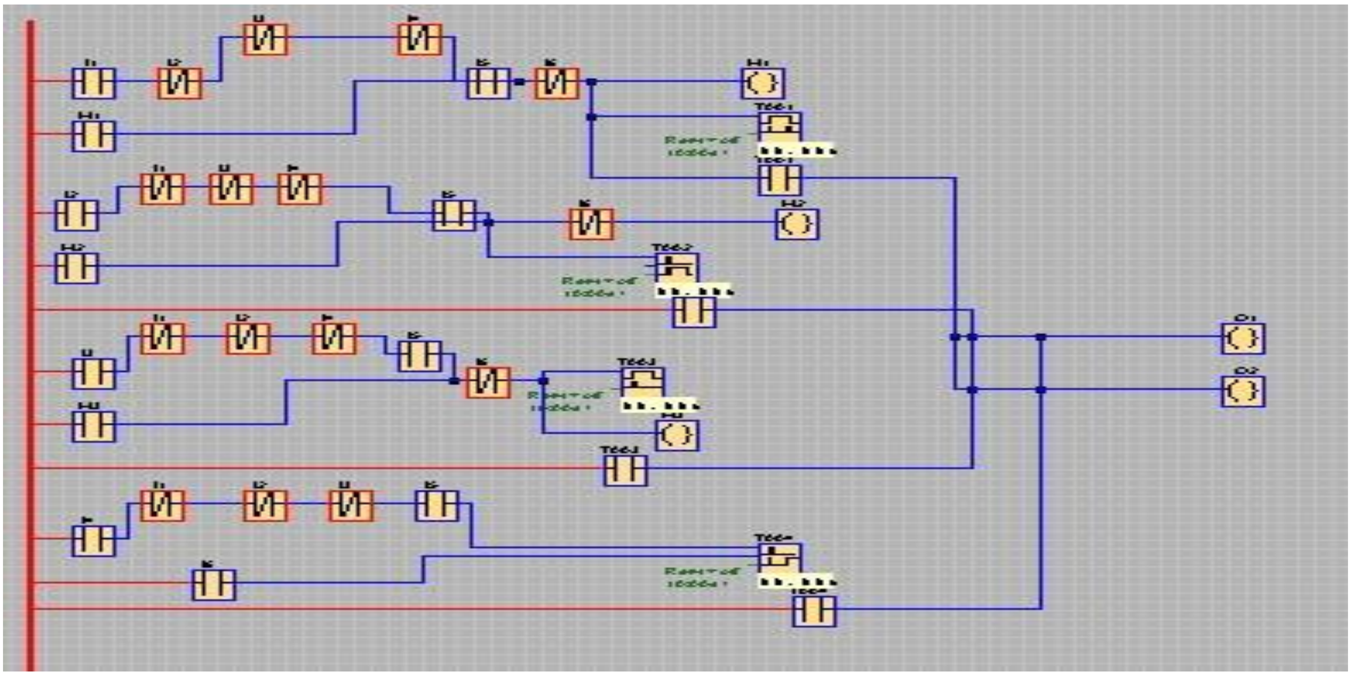

Figure 3. Off mode of PLC program simulation view by LOGO Soft Comfort

Figure 3 shows the 'OFF' mode of the PLC program. After the start of simulation of this mode, the activation of power bar and activation of lines are shown as red lines. The blue line shows the inactivation in this arrangement. The Q1 and Q2 output remains inactive in this mode.

From figure 4 on delay timer mode is shown. The on-delay timer starts counting when the input condition is activated (turned ON). It remains in this state for a preset delay period, during which the associated output remains

inactive. After the delay period has elapsed, the output is activated. Unlike an off-delay timer, which starts its countdown after the input condition is deactivated, the on-delay timer begins counting as soon as the input condition is detected. This means that the output is delayed in turning ON after the input condition is received. The major applications include conveyor belt control, motor startup and sequential operation in this mode.

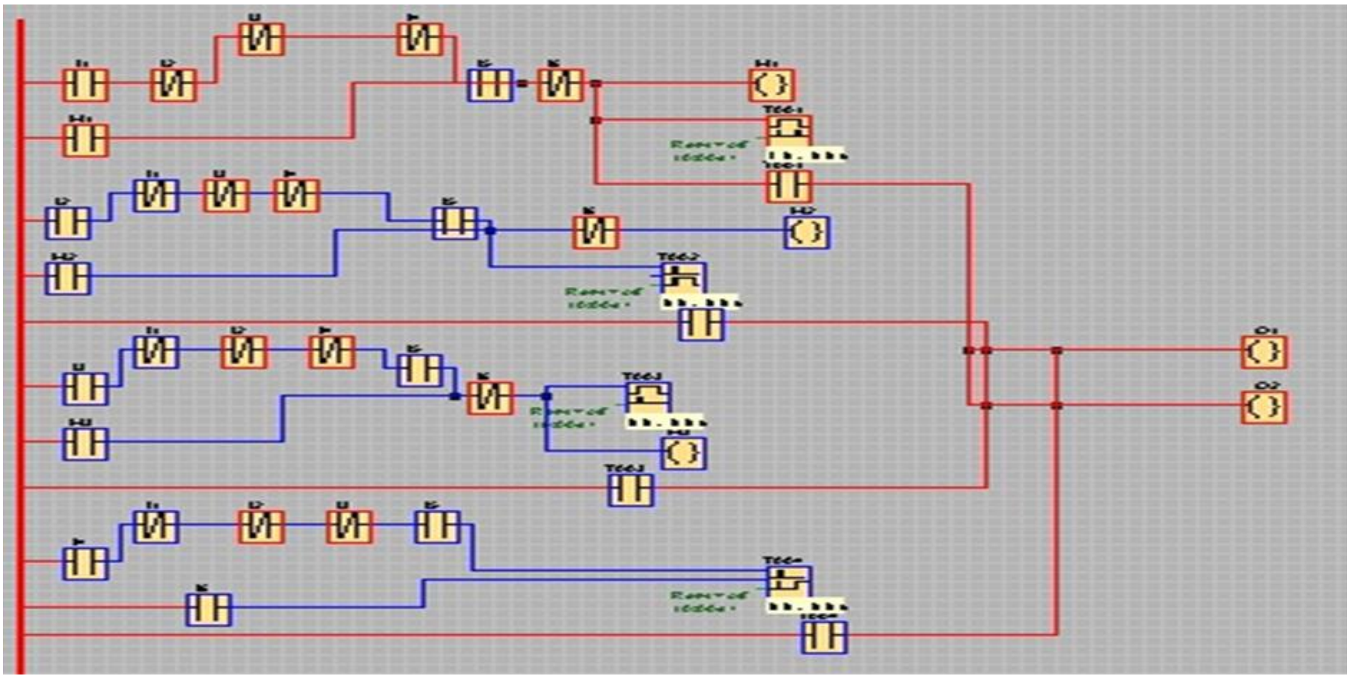

Figure 4. On delay timer mode of PLC program simulation view by LOGO Soft Comfort

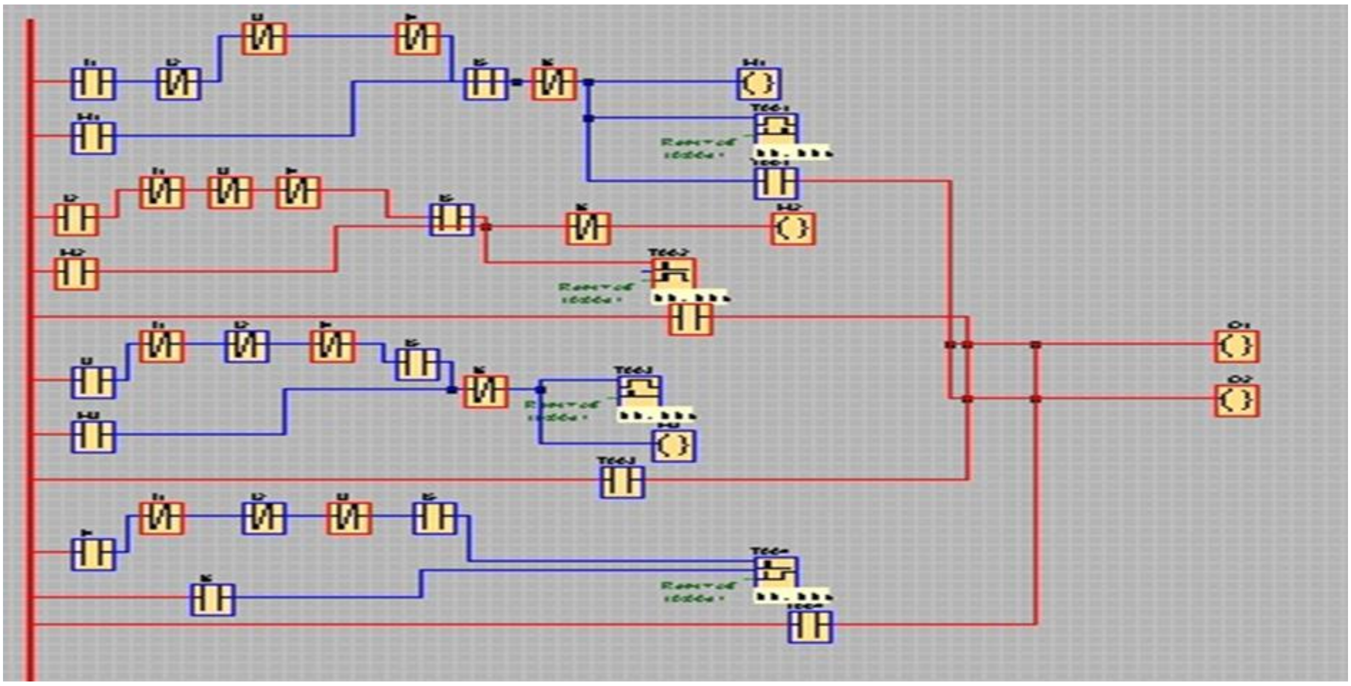

Figure 5. Off delay timer mode of PLC program simulation view by LOGO Soft Comfort

From figure 5 the off delay timer mode has been demonstrated in this mode the outputs remain active but the delay timer is not active. The off-delay timer begins timing when the input condition is activated (turned ON). When the input condition is deactivated (turned OFF), the timer starts its delay countdown. After the preset delay period has

elapsed, the output associated with the timer is deactivated. Unlike an on-delay timer, which starts counting when its input is activated, the off-delay timer starts its countdown only after the input condition is deactivated. This means that the output remains active for a specified duration after the input condition has been removed. Conveyor control, pump control, lighting control these are the applications of this mode.

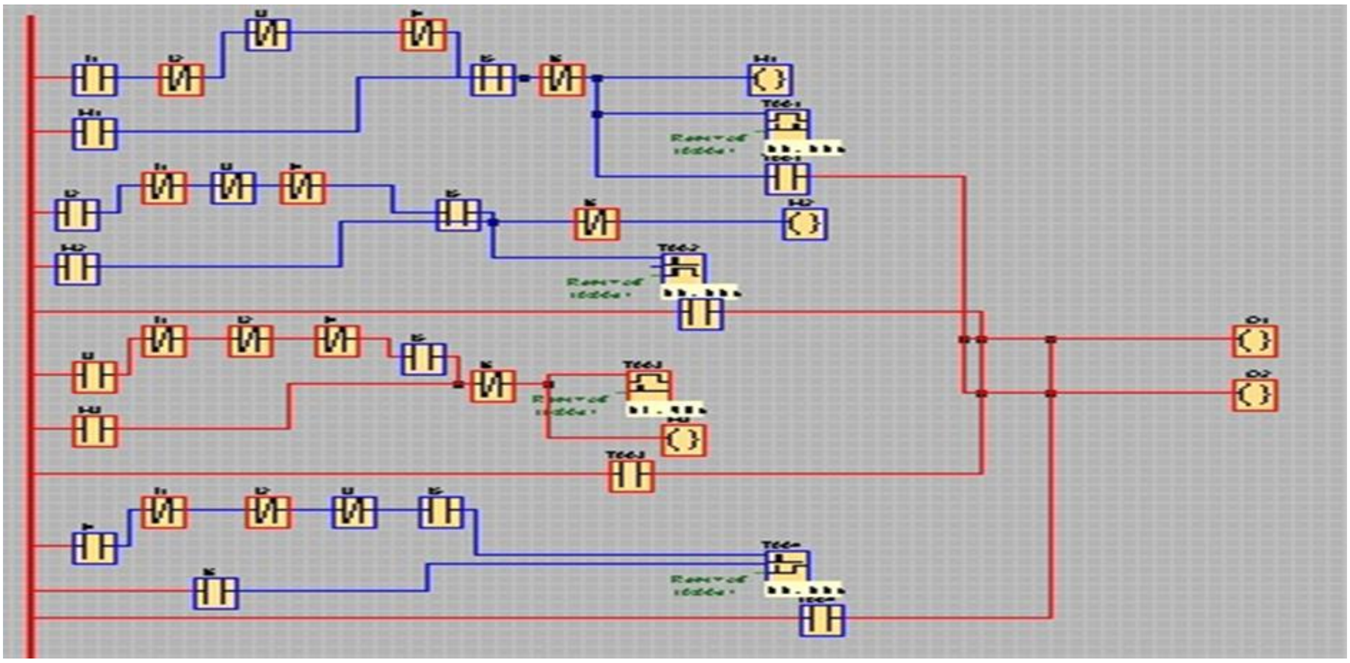

Figure 6. Pulse timer mode PLC program simulation view by LOGO Soft Comfort

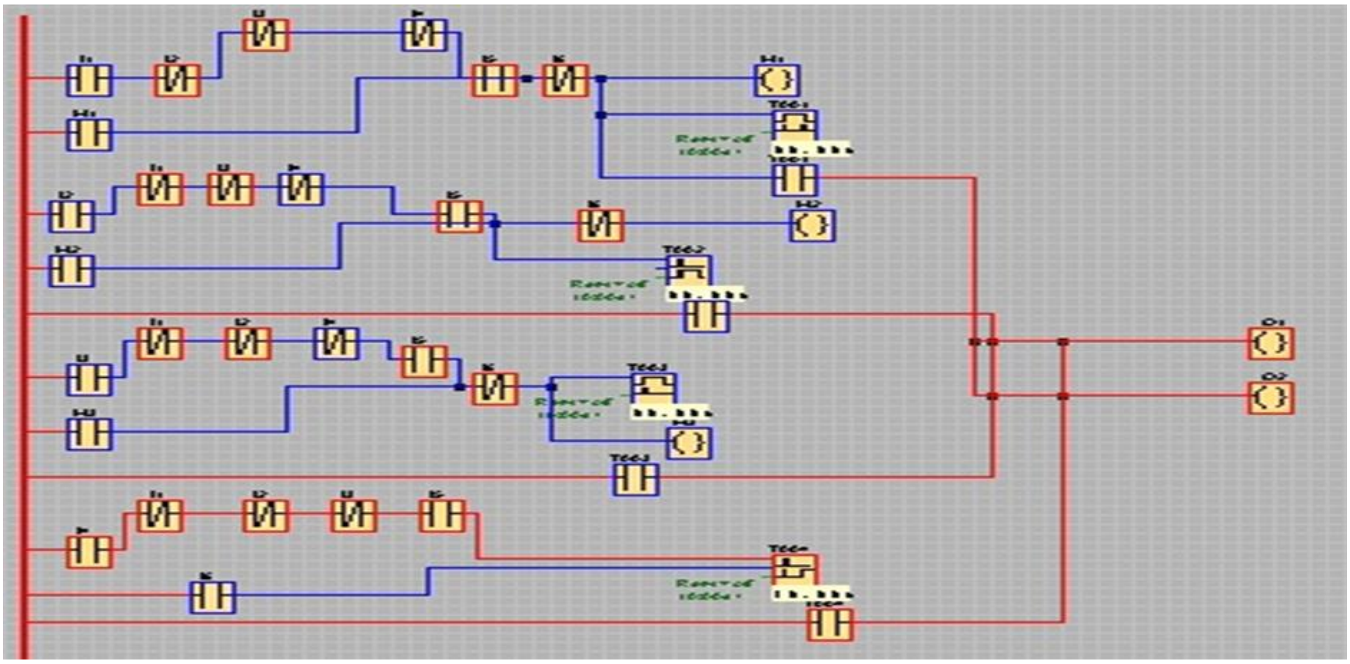

Figure 7. Retentive on delay timer mode of PLC program simulation view by LOGO Soft Comfort

In figure 6 pulse timer mode simulation view shows the activation and deactivation lines due to this mode. In pulse timer mode, when the input condition is activated (turned ON), the timer generates a single output pulse. This pulse typically remains active for a preset duration, known as the pulse width or pulse time. Once the pulse duration elapses, the output returns to its inactive state until the input condition is activated again. Unlike delay timers, which

maintain their output for a certain period after the input condition is activated, pulse timers generate a single, finite-duration pulse regardless of the duration of the input signal. This makes pulse timers suitable for generating precise, controlled pulses in response to specific events. Actuator control, motor control and signal conditioning applications need this type of mode controlling.

In figure 7 retentive on delay timer mode operation has been demonstrated. A retentive on delay timer in a PLC would be a timer that starts counting when it receives an input signal, and after a specified delay period, it activates an output. Importantly, if the PLC loses power or is reset, the timer will retain its accumulated value, ensuring that it resumes counting from where it left off once power is restored. This functionality is commonly used in industrial automation applications where precise timing of events is required, such as controlling the sequencing of processes or coordinating the operation of different components in a system.

In summary, the simulation program outlines the sequential steps involved in operating a PLC system, from powering on to executing ladder logic and generating output signals, ultimately leading to system shutdown upon user command. Each step is crucial for ensuring the proper functioning of the PLC in controlling industrial processes.

4. Conclusion

Siemens LOGO PLC, coupled with PLC-based industrial timer controllers, presents a robust solution for efficient control and automation in small-scale industrial projects. The compactness of the LOGO PLC system, along with its user-friendly programming interface provided by LOGO Soft Comfort, streamlines the development of customized control systems. The ability to conduct offline and online testing, simulation, and program archiving enhances the flexibility and reliability of the system. The integration of PLC timers into the LOGO PLC system offers significant advantages over traditional hard-wired relay and timer logic systems. These timers, including Pulse, On-delay, Retentive On-delay, and Off-delay timers, play pivotal roles in regulating time delays and facilitating production monitoring in various industries. They enable precise control over actions such as machine shutdown after predetermined periods or the initiation of processes following specific delays triggered by sensor activation or button press.

5. Future Recommendations

There are several areas where Siemens LOGO PLC and PLC-based timer controllers can be further enhanced to meet the evolving demands of industrial automation. Firstly, focusing on enhancing integration and compatibility with other automation devices and systems will be crucial. This involves ensuring seamless interoperability with sensors, actuators, and other PLCs, enabling the creation of more interconnected and intelligent automation solutions. Secondly, the development of advanced functionality and features within PLC timers could significantly optimize industrial processes. This could include the incorporation of more sophisticated timer functions or the expansion of the range of available timer types to cater to a broader spectrum of applications. Thirdly, investing in enhancing the user experience by developing more intuitive and user-friendly programming interfaces, as well as providing comprehensive training and support resources, will empower users to leverage the full capabilities of Siemens LOGO PLC and PLC-based timer controllers effectively. Moreover, ensuring scalability and flexibility of

the system is essential to accommodate evolving industry requirements. Regular updates to hardware and software components will be necessary to keep pace with increasing automation needs and technological advancements. Lastly, aligning Siemens LOGO PLC and PLC-based timer controllers with the principles of Industry 4.0 will be crucial. This involves integrating smart manufacturing concepts such as predictive maintenance, real-time monitoring, and data-driven decision-making into the system architecture.

Declarations

Source of Funding

This study has not received any funds from any organization.

Conflict of Interest

The authors declare that they have no conflict of interest.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contribution

All the authors took part in data collection, literature review, analysis, and manuscript writing.

References

[1] Upadrista, V., & Upadrista, V. (2021). IoT Standards with Blockchain. Apress. https://doi.org/10.1007/978-1-4842-7271-8.

[2] Zhang, C., Sun, Y., & Wang, Z. (2021). The Fuel Gas Odorizing Equipment Based on Siemens LOGO! 2021 7th Annual International Conference on Network and Information Systems for Computers (ICNISC). https://doi.org/10.1109/icnisc54316.2021.00038.

[3] Ovatman, T., Aral, A., Polat, D., & Ünver, A.O. (2014). An overview of model checking practices on verification of PLC software. Software & Systems Modeling, 15(4): 937–960. https://doi.org/10.1007/s10270-014-0448-7.

[4] Li, S., Wang, Z., & Sun, Y. (2004). Observer-based compensator design for networked control systems with long time delays. In 30th Annual Conference of IEEE Industrial Electronics Society, IECON 2004, Pages 678–683, IEEE. https://doi.org/10.1109/iecon.2004.1433392.

[5] Kejian, L., Tong, L., Qizhong, C., & Ling, Y. (2010). Design of PLC timer system based on FPGA. In 2010 International Conference on Computer Application and System Modeling (ICCASM 2010), Pages V2–197, IEEE. https://doi.org/10.1109/iccasm.2010.5619282.

[6] Patel, D.M., Shah, A.K., & Shukla, Y.B. (2020). An IEC 61131-3-Based PLC Timers Module Implemented on FPGA Platform. In International Conference on Communication, Computing and Electronics Systems: Proceedings of ICCCES 2019, Pages 501–516, Springer, Singapore. https://doi.org/10.1007/978-981-15-2612-1_48.

[7] Zhao, J., & Liu, L. (2011). PLC timer applications technique. In 2011 International Conference on Electrical and Control Engineering, Pages 5362–5364, IEEE. https://doi.org/10.1109/iceceng.2011.6057047.

[8] Alia, M.A., Younes, T.M., & Zalata, M.A. (2011). Development of equivalent virtual instruments to PLC functions and networks. Journal of Software Engineering and Applications, 4(3): 172. https://doi.org/10.4236/jsea.2011.43019.

[9] He, X., & Chen, X. (2021). Application of PLC-Based Stroke Control in Industrial Production. In IOP Conference Series: Earth and Environmental Science, Volume 632, Issue 4, Pages 042041, IOP Publishing. https://doi.org/10.1088/1755-1315/632/4/042041.

[10] Kosare, A., Moutkar, A., Gomase, A., Koche, V., Kamble, A., Wadhbudhe, B., & Lohakare, P. (2018). Industrial Drives Automation by using PLC. Industrial Journal of Scientific Research in Science and Technology, 4(5): 1113–1117. https://doi.org/10.22214/ijraset.2019.4377.

[11] Chattal, M., Bhan, V., Madiha, H., & Shaikh, S.A. (2019). Industrial automation & control trough PLC and LabVIEW. In 2019 2nd international Conference on Computing, Mathematics and Engineering Technologies (ICoMET), Pages 1–5, IEEE. https://doi.org/10.1109/icomet.2019.8673448.

[12] Kuo, M.M., Andalam, S., & Roop, P.S. (2016). Precision timed industrial automation systems. In 2016 Design, Automation & Test in Europe Conference & Exhibition (DATE), Pages 1024–1025, IEEE. https://doi.org/10.3850/9783981537079_0186.